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INTERSTITIAL POLYCHAETES OF JAPAN I. THREE NEW PISIONID WORMS FROM WESTERN JAPAN[1)]

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With Text-figures 1–4

Many species of the benthic polychaetes inhabiting marine sandy beaches not only utilize the interstices of sand grains as a space to live, but also show some remarkable adaptations to the environment which is considered to be extraordinarily unstable and poor in food supply. Such polychaetes, generally including in addition larger worms apparently incapable of making their ways without removing sand grains, can be considered together an ecologically homogeneous group, viz. interstitial polychaetes (Westheide 1971). Archiannelida, an order of polychaetes primarily adapted for the interstitial life (Hermans 1969), is one of the representatives of this group. And many other genera extending over sixteen families are also known to live in mesopsammic environments (Hartmann-Schröder 1964, Laubier 1967).

In Japan, several species of Archiannelida have been reported from sandy beaches: they are *Polygordius ijimai* Izuka, *P. pacificus* Uchida, *Saccocirrus major* Pierantoni, *S. labilis* Yamanishi and *Trilobodrilus nipponicus* Uchida & Okuda (Izuka 1903, Uchida, T. 1935, 1933, Yamanishi 1973, and Uchida, T. & Okuda 1943). Among other archiannelids, *Dinophilus conclini* Nelson and *D. gyrociliatus* O. Schmidt have been found in aquariums together with *Ophryotrocha labronica* Bacci & LaGrea, a eunicid polychaete, and *Ctenodrilus serratus* (Schmidt) (Uchida, H. 1972, Suzuki & Sekiguchi 1972). Some species of Syllidae belonging to such genera as *Brania, Sphaerosyllis* or *Exogone* might also be referred to interstitial animals. A paraonid worm, *Aricidea jeffereysii* (McIntosh), known as an inhabitant of amphioxus sand (Laubier 1967), has been reported from Sagami Bay at the depth of 300 m (Imajima 1973).

The above names, though by no means large in number, cover, perhaps, all of what have been known as marine interstitial or meiobenthic polychaetes in Japan, since not much interest had been paid on this fauna until recently.

In the course of recent researches on the sandy beach meiofauna, the author could find three species of Pisionidae, one belonging to the genus *Pisionidens* Aiyar & Alikunhi and the others to the genus *Pisione* Grube, in the western part of Japan, viz. the Seto Inland Sea and Kii Peninsula. This is the first record of the family in Japan, at the same time the second one from the coast of North Pacific following the

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discovery of *Pisione longipalpa* Uschakov at the Kuril Islands (Uschakov 1956). And moreover, closer examinations have revealed that all of them represent new species, detailed descriptions of which, together with the diagnoses of relevant genera, will be given in the present paper, the first of the series intended to treat successively the interstitial polychaete fauna of Japan.

The author wishes to express his sincere thanks to Dr. Saburo Nishimura and Dr. Hiro'omi Uchida for their kind advices in the course of the present study.

Family Pisionidae Southern, 1914

Genus *Pisione* Grube, 1856

Elongated polychaetes with numerous setigerous segments. Trunk is ventrally swollen though flattened dorsally; the anterior end is truncated while the posterior tapering gradually. Prostomium is reduced and surrounded by the buccal segment; paired eyes may be placed on it, but are usually brought backwards to the position at one of the first few setigerous segments. The buccal segment is non-setigerous and bears two pairs of cirri, the dorsal one being tentacular and projecting forwards while the ventral one small and flask-shaped, and a pair of long palps ventrally in front of the mouth. Proboscis is well developed and provided with a crown of digital papillae and two pairs of inner jaws. In most species, a pair of stout acicula are found in the buccal segment (buccal acicula), but sometimes they are thin or utterly lost. The next segment (first setiger) usually bears a pair of elongated ventral cirri; the dorsal cirri of second setiger may also be elongated to some extent. The dorsal cirri of first setiger and the ventral ones of the second are both always small globose ones of the same type as are found on every segment posterior to them. Parapodial lobe is well developed and sub-biramous with only an embedded aciculum on the notopodium and a bundle of setae on the neuropodium; a dorsal and a ventral cirri on each parapodium are, as mentioned above, small globose structures. Setae include embedded acicula, simple setae, compound falcigers and sometimes long bladed compound setae. Fertilization in these worms are always achieved through copulation; in males, parapodia of several segments are transformed so as to act as copulatory organs; in females, such modifications are not observed, or, if any, not so conspicuous.

Pisione crassa n. sp.

(New Japanese name: Suna-gokai)

(Text-figs. 1–2)

Occurrence: Sandy beach of very coarse sand. Senri-beach, Minabe, Wakayama-ken; Seto, Sirahama, Wakayama-ken.

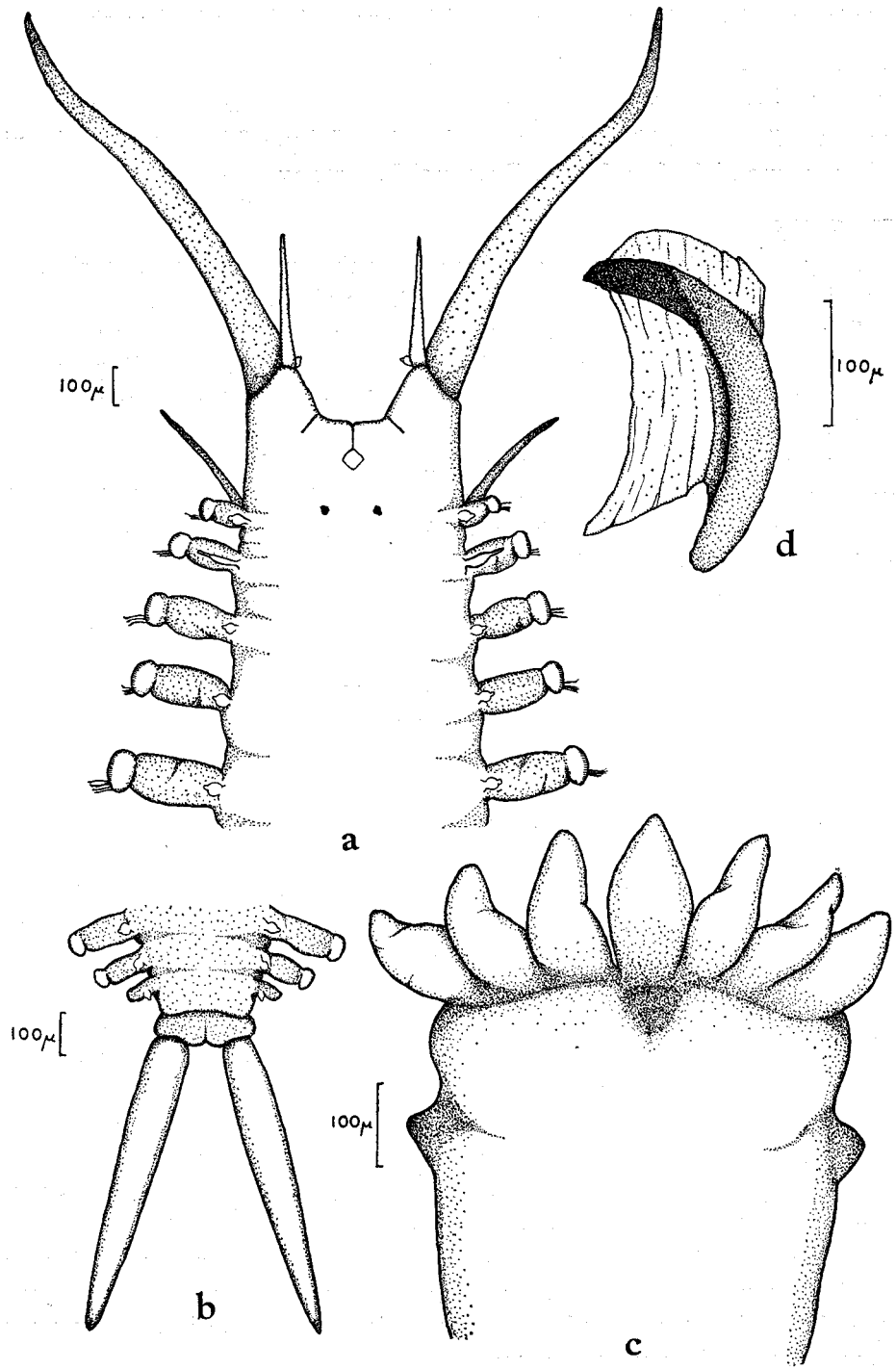


Fig. 1. *Pisione crassa* n.sp.
(a) Dorsal view of anterior end; (b) Dorsal view of posterior end; (c) Anterior end of proboscis; (d) Jaw.

Material examined: 6 male, 5 female and 12 sexually indetermined specimens.

Types: Holotype (male with 85 setigers, 21.0 mm long) from Senri-beach, Jan. 31, 1975 registered as SMBL-Type 272; one paratype (female with 39 setigers, 7.4 mm long) from Seto, Feb. 13, 1975 registered as SMBL-Type 273. Both are deposited in the museum of the Seto Marine Biological Laboratory.

DESCRIPTION

Body is stout, transparent and lustrous at the surface. Large specimens are often pigmented with small dark spots on their dorsal surface.

The worm is rather large compared with other species of the genus: the longest specimen measured 24.0 mm; body width usually 0.7–0.8 mm excluding parapodia; the number of body segments up to 105; no difference in size between males and females.

Prostomium led by an anterior median groove is reduced to a small diamond-shaped structure surrounded by the buccal segment (Fig. 1–a). Brain is embedded a little backward to the prostomium; it is bilobed posteriorly and extends to second or third setigerous segment. No eyes on the prostomium; a pair are, however, located on the brain near its anterior margin at the position of first setiger; each eye spot is composed of two or three grains in piles; an additional pair may be observed on the posterior region of the brain lobes.

Proboscis carries fourteen terminal papillae (Fig. 1–c); two pairs of curved jaws without any dentation are deposited inside (Fig. 1–d).

Palps are long and smooth, usually 0.8–1.0 mm long.

The dorsal cirrus of buccal segment which is about 0.3–0.4 mm long is posteriorly constricted forming a thick basal region; the small ventral cirri are suspended near the bases of the former; a wide "forehead" region is formed between them.

The buccal acicula, about 0.06 mm long, are very thin and appear weak, compared with those of other species of the genus; they never project through the skin anteriorly; their anterior tips are slightly expanded, obliquely truncated without distinct serration (Fig. 2–c).

The ventral cirrus of first setiger is almost as long as the dorsal one of buccal segment; the dorsal cirrus of second setiger is also elongated, but only slightly, never exceeding the parapodial lobe of the same segment in length.

The parapodial lobes are usually 0.4–0.5 mm in length; the presetal lobe is swollen, not bifid, while the postsetal lobe is vestigial (Fig. 2–b).

Setae are composed of two pale acicula, one superior simple seta and four inferior compound falcigerous setae: the end of the superior aciculum (Fig. 2–e) is straight though that of the inferior one (Fig. 2–d) is recurved to some extent; the simple seta (Fig. 2–f) is stout, distally expanded with obliquely truncated end with fine serration; the falcigers (Fig. 2–g) are all homogomph with short serrated blades; compound seta with long blade is absent throughout.

Anal segment bears two long cirri (Fig. 1–b).

In mature males, fertile segments are modified to serve as copulatory organs

(Fig. 2–a): in such segments, body wall at the base of each parapodial lobe rises ventrally and becomes so long that it recurves inwards carrying a small bifurcate digital process near its end; the ventral cirrus is also elongated almost as long as its parapodial lobe; the rest of the parapodial elements such as the main lobe, the dorsal cirrus and the setae, however, show no modifications. The copulatory segments also bear each a pair of sperm sacs; they are repeated as a series for several segments. Ovigerous segments may occur more extensively as shown below.

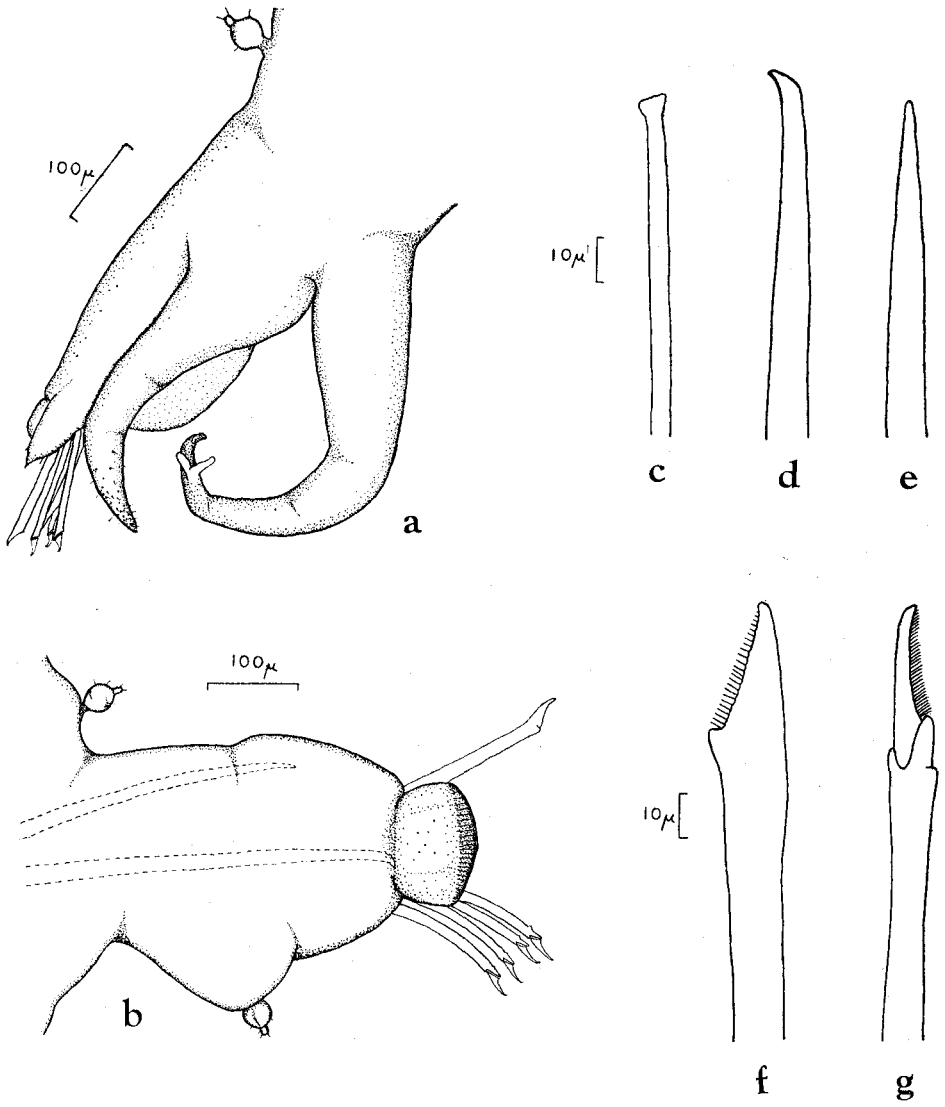


Fig. 2. *Pisione crassa* n. sp. (continued).
(a) Male reproductive segment; (b) Normal parapodium; (c) Buccal aciculum; (d) Inferior parapodial aciculum; (e) Superior parapodial aciculum; (f) Simple seta; (g) Falcigerous seta.

Sex	Number of body segments	Position of segments with sperm sacs or ovaries
♂	64	46–50
♂	67	50–54
♂	70	45–48
♂	85	58–63
♂	105	26–48
♀	39	22–27
♀	74	26–57
♀	95	38–84

The distributional pattern of gonad is, therefore, not constant in either sex. It is not rare that a specimen large enough to get maturity does not have any gonadal elements. Such irregularity might suggest a kind of repeated ripening as the case seen in *Pisione complexa* (Alikunhi 1947).

REMARKS

The present worm is characteristic in the possession of thin buccal acicula, the elongation of the dorsal cirrus of second setiger and the absence of long bladed compound seta.

These features may also be applicable to *Pisione orstedii* Grube, which, however, differs in that the shape of reduced prostomium of the latter is not distinct, that it bears paired eyes on the prostomium itself, and that the degree of elongation of the dorsal cirrus of second setiger is much more extensive, so long as to reach the posterior end of third setiger.

P. africana Day and *P. papillata* n. sp., described below, may also be related to the present species but they apparently differ in the possession of long bladed compound setae and thick buccal acicula.

The worm in question is thus established here as a new species; the name *crassa* comes from its large size as well as its occurrence among very "coarse" sand grains.

Pisione papillata n. sp.

(New Japanese name; Chibi-suna-gokai)

(Text-fig. 3)

Occurrence: Sandy beaches of coarse sand. Hon-jima, Marugame, Kagawa-ken; Hishio, Mukai-jima, Hiroshima-ken.

Material examined: 1 male and 2 sexually indetermined specimens.

Types: Holotype (male with 47 setigers, 7.6 mm long) from Hon-jima, May 25, 1975, registered as SMBL-Type 274; one paratype (specimen with 34 setigers, 4.4 mm long) from Hishio, May 26, 1975, registered as SMBL-Type 275. Both are deposited in the museum of the Seto Marine Biological Laboratory.

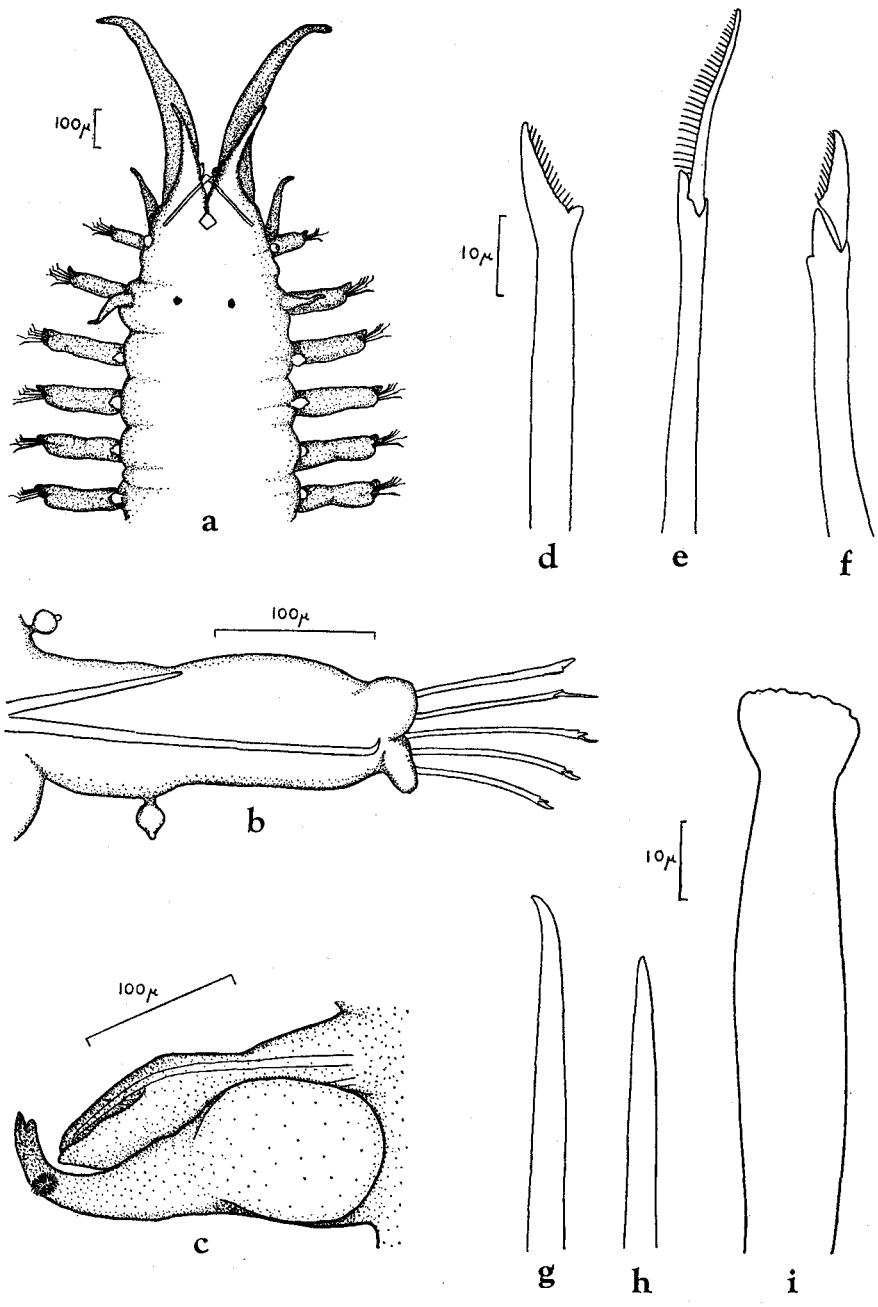


Fig. 3. *Pisione papillata* n. sp.
(a) Dorsal view of anterior end; (b) Normal parapodium; (c) Ventral view of male reproductive segment; (d) Simple seta; (e) Long bladed compound seta; (f) Falcigerous seta; (g) Inferior parapodial aciculum; (h) Superior parapodial aciculum; (i) Buccal aciculum.

DESCRIPTION

Body is relatively small and cirriform; specimens measured up to 7.6 mm in length with more than 95 setigers.

Prostomium is a diamond-shaped structure surrounded by the buccal segment (Fig. 3–a). One pair of eyes are located backwards, on the second setiger, each composed of two or three grains in piles.

The worm has a proboscis provided with a lot of terminal papillae and two pairs of jaws, whose exact shapes have not been studied yet on account of scanty material.

Palps are smooth and measured in the range of 0.3–0.45 mm in length.

The dorsal cirrus of buccal segment is smooth and about 0.25 mm long; the ventral one is small and globular, suspended near the basal part of the former.

Paired acicula are embedded in the buccal segment (Fig. 3–i); they converge forwards and project through the skin in front of the mouth; they are large and stout and about 0.15 mm long, somewhat expanded distally and bluntly serrated at their anterior tips.

The ventral cirrus of first setiger is tentacular almost as long as the dorsal one of the buccal segment; the dorsal one of the second is also elongated though not so remarkable that it is difficult to be recognized in small specimens.

Parapodial lobe is well developed each with a dorsal cirrus attached basally and with a ventral one hung down on the lower margin of the lobe (Fig. 3–b). It has a bifid presetal lobe whose superior ligule is spherical while the inferior one somewhat angular; the postsetal lobe is vestigial.

Two pale acicula are embedded in the main lobe: the superior one (Fig. 3–h) has its tip pointed straight while the inferior one (Fig. 3–g) recurved slightly. The superior seta is a stout simple seta (Fig. 3–d) whose tip is expanded, obliquely truncated and serrated along its cutting margin; the second one with rather slender form is a homogomph compound seta with a long tapering blade serrated at one side (Fig. 3–e); the inferior three are also homogomph compound setae, but carry short, obliquely truncated blade with serrations along their cutting margins (Fig. 3–f).

Anal segment bears two long cirri.

Male reproductive organs were found in one of the specimens which was rather small, with only 47 setigers (Fig. 3–c). It carried a paired sperm sacs filled with sperms on 20th setiger; there the main copulatory organ acting as a long rod-like organ derives itself from an expansion of body wall at the base of the parapodial lobe. The ventral cirrus has also enlarged to a thick digital structure, while the dorsal one remains unmodified. Although the structure of this organ has not been clarified in detail (the specimen was considerably damaged), an adhesive papillose structure called "spinous papilla" (Alikunhi 1947) could be observed on the outer half of the rod-like organ. The original parapodial lobe bears only two embedded acicula, all other setae have disappeared. Testes seemed to appear in the foregoing two segments.

REMARKS

As for the structure of the reproductive organ, this worm well agrees with *Pisione complexa* Alikunhi from India, but differs in the shape and arrangement of the elongated cirri in the anterior segments: the ventral cirrus of first setiger is much shorter and the dorsal one of the second shows no elongation in the Indian species.

The present worm can also be allied to *P. orstedii* Grube and to *P. crassa* n. sp., described previously, in the elongation of the dorsal cirrus of second setiger. But it differs definitely from the former in the degree of elongation (so long as to reach the end of third setiger in *P. orstedii*), and from the latter in the possession of long bladed compound setae.

Among the known species of the genus, the present worm most closely resembles *P. africana* Day, seemingly differing only in their copulatory devices: in the African species, none of the setae on copulatory segments has been lost, and spinous papilla is absent; it may also be added to these differences that the dorsal cirrus of buccal segment is constricted to form a distinct basal region in the African species though it is smooth in the present species.

Thus the worm in question is distinguishable from any other species of the genus in the combinations of such characters as the arrangement of elongated cirri in the anterior segments, the setal pattern and the structure of male reproductive organ. So it is proposed here as a new species under the name *papillata* which is derived from the possession of spinous papillae.

Genus *Pisionidens* Aiyar & Alikunhi, 1943

Elongated polychaetes whose trunks are dorsally flat and ventrally swollen and tapering at both ends. The body surface is smooth and without any annulation. Prostomium is almost invisible, being reduced and enveloped in the buccal segment. The segment extends anteriorly with a pair of dorsal cirri (antennal cirri) which are constricted at the basal region leaving an median groove, which affords an evidence of the fusion of the segment in front of the prostomium. There the ventral cirri, which can be recognized as small globose structures in *Pisione,* have completely disappeared. The segment also extends backwards giving an extremely elongated appearance. Mouth and palps are situated ventrally on the middle part of the segment. Some paired eyes are located also on the segment. Buccal acicula are not visible. Retractile proboscis is provided with a crown of terminal papillae together with two pairs of inner jaws with some chitinous membranes. On the contrary, the following two segments are much shortened, each bearing two pairs of cirri; the ventral pair of the former segment and the dorsal pair of the latter are formed into elongated cirri (ventral and dorsal tentacular cirri), while the others remain as minute globose structures. Parapodia are mainly of adhesive function with many mucous glands on the outer margins of their main lobes, and have lost their setae in adults except for an embedded aciculum; the dorsal and ventral cirrus attached to the main lobe

are in the shape of small globose structures. Several anterior segments are provided with special reduced parapodia (rudimentary parapodia) composed of only two minute globose structures and lacking the main lobe as well as the acicula. The worms always carry copulation to perform fertilization. Mature males are provided with some of their parapodia modified into lateral copulatory organs; they also bear some hole-like structures called ventral pore (as geital papilla by Aiyar & Alikunhi, 1940) mid-ventrally on some segments. In females, paired receptacula seminis may develop as genital papillae (Hartmann-Schröder 1970).

Pisionidens maturata n. sp.

(New Japanese name: Hadaka-suna-gokai)

(Text-fig. 4)

Occurrence: Sandy beaches of very coarse sand. Seto, Sirahama, Wakayama-ken.

Material examined: 10 male, 9 female and 7 sexually indetermined specimens.

Types: Holotype (male with 82 segments, 28.8 mm long) from Seto, Oct. 16, 1975, registered as SMBL-Type 276; 1 paratype (female with 73 segments, 26.0 mm long) from Seto, Oct. 17, 1974, registered as SMBL-Type 277. Both are deposited in the museum of the Seto Marine Biological Laboratory.

DESCRIPTION

Elongated translucent worms actively moving about among sand grains. The surface of body wall is smooth and lustrous. The specimens can reach almost 30 mm in body length; body width of mature specimens is usually 0.6–0.7 mm, excluding parapodia; body segments numbered up to 83; adult females look somewhat thicker than males.

A pair of eyes each composed of two or three grains are found on the posterior half of the buccal segment (Fig. 4–a).

The crown of proboscis consists of eighteen digital papillae with two small lateral ones in addition. The amber coloured jaws show slight inner dentations at the anterior ends where they curve inwards widening to some extent (Fig. 4–b); their posterior halves are straight showing no kind of projections or crevices (cf. Siewing 1954).

Among the four pairs of anterior appendages, the dorsal tentacular cirrus is the longest; next to this are the palp and the ventral tentacular cirrus that are of subequal length to each other; the antennal cirrus is much shortened almost half as long as the dorsal tentacular cirrus. They are all smooth and slender but for the palp whose distal part shows slight annulation.

Rudimentary parapodia always occur from first to fifth segment (counted excluding those with anterior appendages).

Male ventral pores are located in a series or two: the anterior one usually begins

at ninth segment and continues for three or four segments that are sterile carrying neither sperm sacs nor testes; the posterior one could be seen only on those specimens which have attained to full growth, and on several segments around the twenty-fifth. A row of paired sperm sacs accompanied with lateral copulalory organs are borne on some (usually four) segments of the posterior series as shown below, and never to be seen on those without ventral pores or on the anterior series.

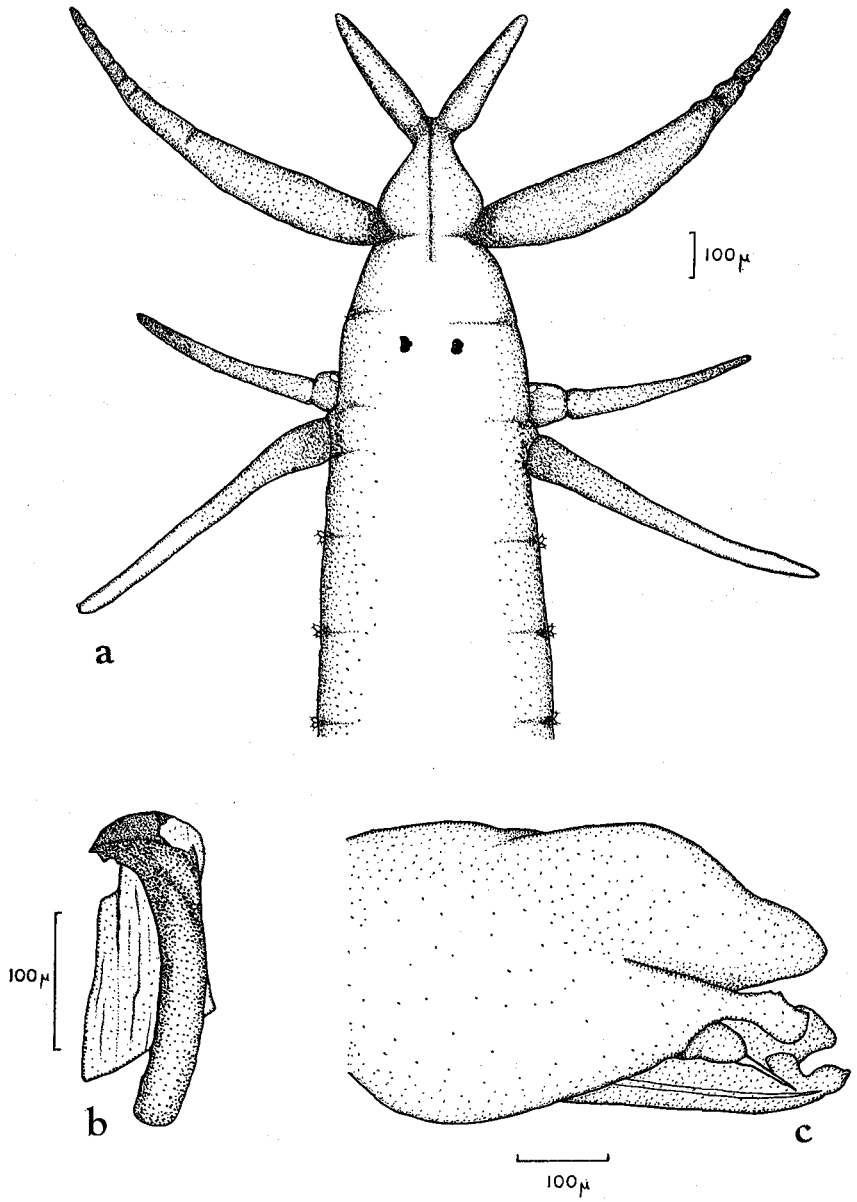


Fig. 4. *Pisionidens maturata* n. sp.
(a) Dorsal view of anterior end; (b) Jaw; (c) Ventral view of male reproductive segment.

Number of body segments	Position of ventral suckers	Position of sperm sacs
26	9–11	
29	9–11	
36	9–12	
64	10–12	
64	9–12	
	? – ?	25–28
64	10–12	
	26–32	28–31
65	9–12	
	25–32	28–31
77	9–11	
	? – ?	29–33
82	9–11	
	26–30	27–30

The lateral copulatory devices include a dorsal, distally bilobed lappet with an aciculum which indicates its derivation from the main parapodial lobe, and a large ventral expansion into which penetrates the sperm sac (Fig. 4–c); the latter thrusts backwards a chitinized tubular spine used for the transfer of sperms and below it a single ventral lappet presumably of supplementary function to the former. The original dorsal and ventral cirri are no longer to be seen.

In mature females, eggs are carried in a long series and continue nearly to the end of their body as shown below. No special copulatory devices such as genital sucker has been observed in them.

Number of body segments	Position of ovigerous segments
62	18–53
68	19–56
68	18–63
69	18–55
70	18–54
72	19–62
78	16– ?

REMARKS

The genus has hitherto comprized only one species, *Pisionidens indica* (Aiyar & Alikunhi 1940). The worms reported under this name are known to distribute widely in the tropical regions of the world: Madras (Aiyar & Alikunhi 1940), Calcutta (Aiyar & Alikunhi 1949), San Salvador (Siewing 1953), Brazilian coasts (Siewing 1953 and Westheide 1974), South Africa (Tebble 1953, Day 1962, 1967, Hartmann-Schröder 1970 and 1974), Madagascar (Delamare-Deboutteville 1956), Red Sea (Hartmann-Schröder 1960) and Malaysia (Renaud-Mornant & Serene 1967). No record, however, has been made from temparate regions so far. Among the tropical populations, those from Madras (Aiyar & Alikunhi 1940) and South Africa (Hartmann-Schröder 1970) were studied in details; they show some differences from each other, though the number of specimens observed by the Indian authors was not

large enough to complete such comparison. The present report marks the first record of the genus from temperate region, and a detailed comparison with the two descriptions based on tropical populations referred to above has revealed that the present form is clearly separable from both of the tropical ones as shown in Table 1.

Table 1. Comparison of *Pisionidens maturata* with the populations of *P. indica* from India and South Africa (segments counted excluding those with anterior appendages).

Characters	*P. maturata* from Japan	*P. indica* from India	*P. indica* from South Africa
Body length	up to 30 mm	14 – 18 mm	up to 30 mm
Number of body segments	up to 82	50 – 60	30 – 68
Rudimentary parapodia	1st – 5th	1st – 4th	1st – 5th or 6th
Ventral pores			
Male	anterior and posterior series	anterior and posterior series	anterior and posterior series or a long one
Female	absent	posterior series present	absent
Sperm sacs	4–5 pairs in a series	usually 2 pairs	1 – 3 pairs
Ovaries	a long series from about 18th to posterior half	a few ovarian groups confined to middle segments	a few ovarian groups confined to middle segments
Lateral copulatory organ			
Dorsal cirrus	lost	present	present
Main lobe	a bilobed lappet	unmodified	unmodified
Outer end of sperm sacs	with a chitinized spine and a single lappet	three-lobed structure the median one being hook-like	three-lobed structure the median one being hook-like
Receptacula seminis	?	between ovigerous segments	between ovigerous segments

No difference can be seen in their basic structures such as body shape, anterior appendages or shape of parapodia. The position of rudimentary parapodia is constantly from 1st to 5th segment in the present form, while from 1st to 5th or 6th in the African form and from 1st to 4th in the Indian form. Male ventral pores are arranged as anterior and posterior series or as only a long series in all of them; in females, on the other hand, ventral pores have been observed only on the Indian specimens, though they are drawn also on the African specimens as star-like structures by Day (1967 p. 134). Several pairs of sperm sacs are accompanied with lateral copulatory organs on mature males: they are four or five pairs in a series in the Japanese worms, usually two and often three pairs in the Indian worms and from one to three or rarely seven pairs in the African worms. Ovaries are arranged as a long series from about 18th to posterior region of the body in Japanese females, whereas they are two to five pairs of ovarian groups confined to middle segments in the Indian specimens, or usually five such groups, each with two pairs of ovary, also confined to middle-posterior segments in the African specimens. Receptacula seminis which are always situated between the ovarian groups in both Indian and African specimens

could not be observed in the Japanese worms. The structure of lateral copulatory organ greatly differs between the tropical and the Japanese populations: firstly, the dorsal cirrus is lost in the latter whereas it remains unmodified in the former: secondly, the main parapodial lobe has modified itself to a thin lappet with an aciculum in the latter while they also remain unmodified in the former; lastly, the outer end of sperm sac has become a chitinized tubular spine with a thin single lappet in the latter while it has become a grooved spatular structure with two conical and one hook-like processes in the Indian worms or a three-lobed structure with the median lobe being transformed into a prolonged hook in the African worms. The present worm is, therefore, distinguishable from the two tropical populations mainly in the peculiar form of copulatory device and in the developmant of a long series of ovigerous segments (hence the name "*maturata*"). The position and its constancy of rudimentary parapodia and the number of paired sperm sacs may also be added to characterize the present worm. Such differences as are comparable to what is noted above might be revealed even among tropical populations if more detailed studies are made on them. Recognizing, however, that the difference concerning the way of reproduction can be regarded of a supreme importance in determining species, the present form is comfirmed to be separable from *P. indica* and erected here as a new species under the name *maturata*.

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